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IS 1354 (1992): Methods of test for coke special test [PCD
7: Solid Mineral Fuels]



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“Knowledge is such a treasure which cannot be stolen”

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भारतीय मानक

कोक की परीक्षण पद्धतियां — विशेष परीक्षण

(दूसरा पुनरीक्षण)

Indian Standard

**METHODS OF TEST FOR COKE —
SPECIAL TESTS**

(Second Revision)

UDC 662.749.2 : 620.1

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BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

FOREWORD

This Indian Standard (Second Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Solid Mineral Fuels Sectional Committee had been approved by the Petroleum, Coal and Related Products Division Council.

This standard was first published in 1959 and revised in 1964 consequent upon adoption of metric system in India. The Committee responsible for the preparation of this standard decided to revise it again in light of the experience gained in the past so as to update the same.

In the present version the details of method for determination of bulk density has been excluded since the same is duly covered in IS 7190 : 1974 Methods of determination of bulk density of coke. Besides, Half Micum test has been adopted as an alternate to Micum test on the basis of investigational work done at Central Fuel Research Institute. Details of Haven test, which is a relative measure of resistance of coke to degradation by abrasion in terms of stability factor and hardness factor, have also been excluded since the practice of this test is not in vogue in the present day context.

In the formulation of this standard, due weightage has been given to the international co-ordination among the standards and practices prevailing in different countries in addition to relating it to the practices in the field in this country. This has been met by deriving assistance from the following publications:

ISO 556 : 1980 Coke (greater than 20 mm in size) — Determination of mechanical strength. International Organization for Standardization;

ISO 616 : 1977 Coke — Determination of shatter indices. International Organization for Standardization;

ISO 1014 : 1985 Coke — Determination of true relative-density, apparent relative density and porosity. International Organization for Standardization;

BS 1016 : 1942 Methods for the analysis and testing of coal and coke. British Standards Institution; and

ASA K 18.1-1948 Methods for the laboratory sampling and analysis of coal and coke. American Standards Association.

The committee also had the benefit of studying the various documents on the method of determination of true specific gravity, apparent specific gravity and porosity, issued by the Technical Committee ISO/TC 27—Solid Mineral Fuels of the International Organization for Standardization (ISO). Furthermore, extensive help has been derived from the researches conducted in the Central Fuel Research Institute, Dhanbad, which have enabled the Committee to formulate this standard on the basis of requirements of Indian coals and coke.

The shatter test is based on square-aperture sieves dimensioned in inches because it was first developed and widely used in the United Kingdom and the United States of America. The results of this test are reported as 3, 2, 1.5, 1 and 0.5 inch shatter indices. There has been considerable discussion on the adoption of Indian standard sieves as given in IS 460 : 1985 'Specification for test sieves'. However, the Committee felt that no investigations on shatter indices have been carried out using IS sieves. It was, therefore, decided to retain the inch sieves and put, in view of the adoption of metric system in the country, equivalent values rounded to the nearest centimetre for the apparatus and nearest millimetre for the sieves in this standard. It has also not been possible to state the permissible tolerances for the sieve plate thicknesses and apertures, including the mean tolerances, and there has been some difference of opinion as to whether the results of the tests may be invalidated if close tolerance are not adhered to.

However, in the case of Micum test, the use of round-aperture sieves dimensioned in metric units is standard, as this test is widely used in the countries of Europe using metric system; although the first drum test from which it was developed originated in the United Kingdom.

(Continued on third cover)

Indian Standard

METHODS OF TEST FOR COKE — SPECIAL TESTS

(Second Revision)

1 SCOPE

1.1 This standard prescribes the methods of test for coke, for the determination of Shatter index, Micum index, Half-Micum index true specific gravity, apparent specific gravity and porosity.

1.2 Should any inconsistency exist between the methods of test given in this standard and those if any, given in the material specifications for coke, the latter shall prevail.

2 REFERENCES

Following Indian Standards are necessary adjuncts to this standard:

<i>IS No.</i>	<i>Title</i>
436 (Part 2) : 1965	Method of sampling of coal and coke: Part 2 Sampling of coke (<i>revised</i>)
437 : 1979	Specification for size analysis of coal and coke for marketing (<i>third revision</i>)
460 (Part 2) : 1985	Perforated plate test sieves (<i>third revision</i>)

3 SAMPLING

3.1 Subject to the provisions of 3.2 to 3.7, the methods of sampling prescribed in IS 436 : (Part 2) : 1965 shall be followed in the preparation of samples.

3.2 Gross Sample for Shatter and Abrasion Tests

The quantities of samples for the Shatter, Micum, and Half-Micum tests are given below:

<i>Test</i>	<i>Mass of Gross Sample (kg)</i>
Shatter	110
Micum	250
Half-Micum	125

These quantities shall be collected by increments distributed evenly over the whole lot of coke to be sampled and the pieces taken shall

be representative of the different sizes of coke lumps in the consignment. Each increment shall consist of a single piece of coke, over 50 mm in size and the pieces taken shall be representative of the different sizes of coke lumps in the consignment.

3.3 Sample for True Specific Gravity

The analysis sample, consisting of 0.5 kg of air-dried coke, ground to pass 212-micron IS Sieve (*see* IS 460 : 1985) shall be used for the determination of true specific gravity.

3.3.1 In case an analysis sample, ground to pass 212-micron IS Sieve is not received in the laboratory, a sample of air dried material shall be prepared in the manner prescribed under 2.4.2 of IS 436 (Part 2) : 1965 from the sample of coke received in the laboratory.

3.4 Gross Sample for Apparent Specific Gravity

For apparent specific gravity, a sample of about 50 kg shall be collected by increments distributed evenly over the whole lot of coke (above 25 mm) to be sampled. These increments have to be so collected that they are truly representative of the material with regard to size, shape and general appearance.

4 SHATTER TEST

4.1 Principle

The test is designed to simulate the effect of dropping coke on loading, dropping into bunkers and to the charge level of a blast furnace. It measures, therefore, the resistance to shattering, or the impact hardness, as distinct from the surface hardness, which is measured in abrasion test (*see* 5 and 6). A representative sample of the coke over a certain specified size is dropped under standard conditions, the resistance to breakage being measured by the percentage of the cock which remains on different sieves after the test, or by some mathematical expression of these values.

4.2 Number of Tests

Three tests shall be conducted.

4.3 Apparatus

The assembly of the apparatus is shown in Fig. 1. It is mounted over a concrete floor and consists of the parts given below.

4.3.1 Box

The box is 71 cm long, 46 cm wide and 38 cm deep, supported by pulleys and wire ropes so that the inside of the bottom of the box is 183 cm above the base plate when the coke is dropped. The bottom of the box consists of two doors, hinged lengthwise and provided with a latch for rapid opening. The doors are of 6 mm plate so that they swing open rapidly and not impede the fall of the coke. The sides of the box may be made of either 6 mm or 3 mm plate. Guides fastened to the end plates of the box engage with the main vertical side supports of the apparatus which are fastened to the side plates surrounding the base plate.

4.3.2 Base Plate

The base plate is rigid, not less than 12.5 mm thick, 122 cm long and 97 cm wide. The base plate has side plates 20 cm high and 6 mm thick on all sides to prevent loss of coke during a test. The back of the machine (the counter weight being to the right of the machine) and side plates are rigidly fastened and the front plate is hinged and fitted with latches so that it can be lowered to shovel the coke from the base plate to the box after each drop.

4.3.3 Framework

The main vertical supports are fastened to the outside of the side plates of the base plate and also to a top plate to support the pulleys from which the box is suspended. The vertical supports are kept outside the base plate to facilitate shovelling the coke after each drop. If the plate is supported on a framework of angle-iron, the vertical supports shall be riveted or welded to the angle-iron to assist rigidity. Guides approximately 250 mm long are fitted to the end plates of the box to engage with the main vertical supports. Each vertical support may be built up in either of two ways. In one type, each vertical support may consist of a T-section 150 mm wide with a 60-mm web in which case the box guide should be able to run on either side of the web of the T-section the web of which is removed where it is fastened to the side plate or the base plate. Alternatively, the vertical support may consist of two 80×80 mm angles set 12.5 mm apart so that a 6-mm guide plate from the box moves in the slot between the two angles.

4.3.4 Top Plate and Counterweights

The top plate is 15 to 20 cm wide, 6 mm thick; it supports two pulleys from which the box is suspended by two wire ropes which are connected to the guides on the end plates near the box. The wire ropes are fastened to the box guides near the side supports so as to interfere as little as possible with reloading of the coke into the box after each drop and to use only one pulley at the counterweight end. Central suspension of the box is not advised because of the interference with the reloading operation. A counterweight is suspended from the other ends of the two wire ropes so that a double pulley is necessary at the right-hand end. The counterweight consists of a fixed weight equal to that of the box, and two 12-kg removable weights which are slotted into rods which pass through the centres of the fixed weights.

4.3.5 Box Stop

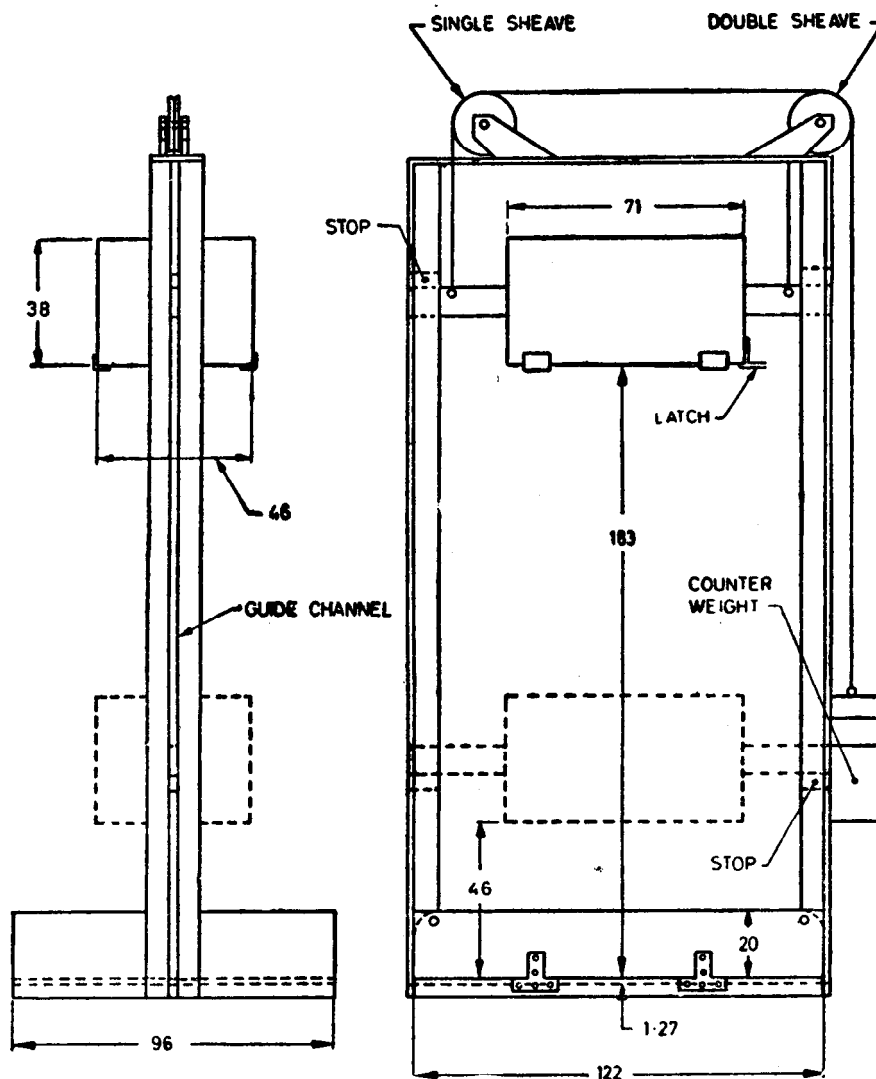
Stops are fitted to ensure that the inside of the bottom of the box is exactly 183 cm from the base plate when the box is raised, and to prevent the box from falling on to the coke when the box is lowered. A convenient distance of the bottom of the box from the base plate for reloading is 46 cm. The stops limit the upward and the downward movement of the box guides. These stops may consist of plates filling the slot between the double angles, when these are used as the main vertical support. Alternatively, when the side supports consist of T-sections, the distance piece fixing the width of the slot between the double guides may be extended vertically to give a stop with the top plate; the stop to prevent the box from falling on the coke should be fixed on the web of the sections.

4.3.6 Sieve Plates

The sieve plates shall be machine-stamped with parallel apertures from mild steel plate with square apertures. The apertures shall have an average tolerance of approximately 0.2 percent and a maximum tolerance of approximately 0.5 percent. The sieves shall be made 60 cm square and supplied with 20 cm thick hard wood sides, screwed to the plates and armoured with horizontal angle plates to prevent wear. The details of the sieves are given in Table 1. When the wear on any aperture exceeds 2 percent, the aperture is blanked off or the test sieves changed.

4.3.7 Containers

Suitable containers made of 2.00 or 2.50 mm galvanized sheet, to hold 25 kg of shattered



All dimensions in centimetres.

FIG. 1 SHATTER TEST APPARATUS

coke, are shown in Fig. 2. A set of 3 large and 3 small containers is convenient. They should have their approximate tares marked on them, the final tare being checked each time before use. The small unit will hold the separate single fractions in the size analysis if a good concrete floor is not available.

4.3.8 Weighing Machine

A counter platform weighing machine with a maximum capacity of 50 kg and sensitive to 25 g or less is essential for weighing. This machine should be brushed at regular monthly or shorter intervals to keep the knife edges free from dust. The machine should be re-calibrated at regular intervals.

4.4 Size Analysis Before the Shatter Test

4.4.1 Subject the whole of the gross sample to a size analysis as prescribed in IS 437 : 1979. It is necessary to determine the percentage of the fractions above 50 mm in a preliminary test so that they may be mixed in the relative proportion in which they are found in the gross sample. It is usually convenient to start with a nest of perforated plates of 102, 76, 64, 51, 38, 25, and 13 mm apertures. Should the 'over 102 mm' fraction exceed 10 percent of the gross sample, hand place it on 127 mm or larger sieve till not more than 10 percent is graded oversize.

Table 1 Details of Sieves for Size Analysis and Shatter Testing of Coke

(Clause 4.3.6)

Aperture	Thickness of Plates	Width of Bridge	No. of Apertures per Side	Depth of Side Frame	Maximum Permissible Wear
(1)	(2)	(3)	(4)	(5)	(6)
mm	mm	mm		mm	mm
127	5.00	32	3	127	1.3
102	5.00	25	4	127	1.0
76	3.00	19	6	127	0.8
64	3.00	16	7	102	0.6
51	3.00	13	9	102	0.5
38	3.00	10	12	102	0.4
25	3.00	6	18	76	0.2
13	3.00	6	30	76	0.1

4.4.2 Weigh the 'on 102 mm', 'on 76 mm', 'on 64 mm' and 'on 51 mm' fractions and record their net mass and place them in separate piles on the floor. These are the fractions from which the shatter test is made. It is convenient to separate the 'on 102 mm' size from all the samples before removing the 102-mm sieve from the nest to have only one weighing for this size. Whether this can be done or not, depends on the amount of 'under 102 mm' coke present; if the amount of 'under 102 mm' coke fills one of the sieves, the whole operation may have to be repeated until the 'on 102 mm' coke has been removed from all the gross sample.

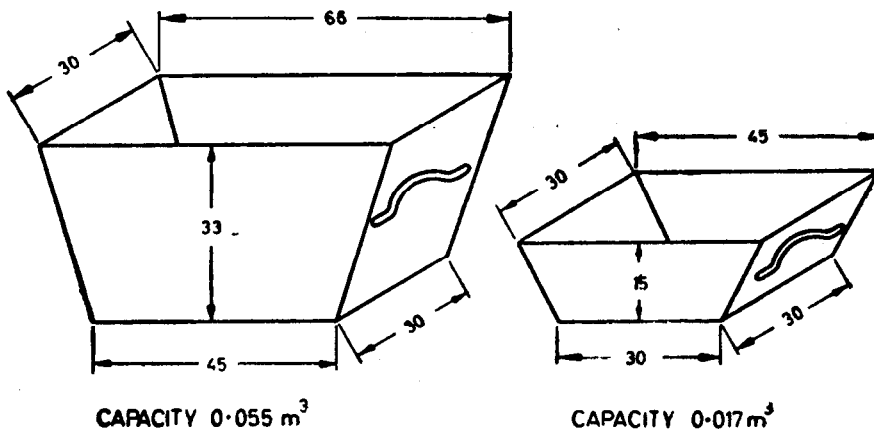
4.4.3 Complete the size analysis by hand placing of the gross sample 'on 38 mm' and by hand sieving, 'on 25 mm' and 'on 13 mm'. Record the net mass, including the 'through

13 mm'. Reject the under 51 mm' fractions.

4.4.4 Express the mass as decimals and record the results as cumulative percentages starting with the largest size.

4.5 Preparation of Sampling for Testing

4.5.1 The 25 kg of 'over 51 mm' coke containing the '51 to 64 mm', '64 to 76' '76 to 102 mm' and 'over 102 mm' (or '102 to 127 mm' and 'over 127 mm') sizes in the approximate percentages found in the approximate percentages found in the preliminary size analysis and selected at random is prepared as in 4.4.2. If the coke contains 3 percent of moisture or more, air-dry to a moisture content of less than 3 percent, since small particles under 1.5 mm may adhere to larger particles and lead to weighing errors.



All dimensions in centimetres.

FIG. 2 CONTAINERS FOR USE IN THE SHATTER TEST

4.5.2 Weigh the 'over 102 mm' fraction in the approximate percentage found in the 'over 51 mm' portion of the sample of coke used for size analysis, into a large container and add to it the 'over 76 mm' and 'over 64 mm' to the approximate amount required. Finally add the 'over 51 mm' fraction to give $25 \text{ kg} \pm 13 \text{ g}$. Should the 'over 102 mm' exceed 10 percent of the original gross sample it would have been separated into '102 to 127 mm' and 'over 127 mm' and these fractions will be used *pro rata*.

4.6 Procedure

4.6.1 Carefully empty the 25 kg of 'over 51 mm' coke into the box of the shatter apparatus, dropping it as little as possible in this process. Do not empty the container by tipping it from the top of the box, but place the coke by hand in the box. Raise the box to the standard height, close and latch the front plate of the base and displace the latch of the shatter test box to allow the coke to fall on to the base plate.

4.6.2 Close the bottom doors of the box and replace the latch. Do not stand on the coke to perform this operation. Lower the box until the lower stop halts it. Drop the front base plate and shovel the coke from the base plate into the box, care being taken to lower the coke into the box without dropping. Return the coke 'over 13 mm' in size from the base plate to the box using the shovel and without sweeping at this stage. Repeat the process until four drops in all have been given.

NOTE — It is important to be able to determine the 13 mm shatter index with an accuracy of the order 40 g on 25 kg coke sample. Possible loss of dust makes it desirable to express the 13 mm shatter index directly and not by difference. If an error of 13 g occurred for each of the separate weighings of the 'over 102 mm', '102 to 76 mm', '76 to 64 mm', '64 to 51 mm', '51 to 38 mm', '38 to 25 mm', '25 to 13 mm' fractions after a test, this error would be exceeded. The separate fractions are, therefore, added together into one container so that only one error of weighing is possible in each of the cumulative fraction 'on 102 mm', 'on 76 mm', 'on 64 mm', 'on 51 mm', 'on 38 mm', 'on 25 mm' and 'on 13 mm' whilst a balance is made to see that the whole of the coke $\pm 25 \text{ g}$ is accounted for.

4.6.3 Arrange a nest of sieve plates of 102, 76, 64, 51, 38, 25 and 13 mm square aperture, with the sieve of largest aperture at the top. Shovel the coke from the base of the apparatus on to the top sieve plate and complete the emptying of the base plate by sweeping up all the dust. Shake vertically the top sieved plate to allow most of the undersize material to pass through and hand place the residue on the sieve until

no more will pass. Transfer the 'over 102 mm' into the container and record its mass. Similarly shake the 76 mm sieve and hand place the residue on the sieve plate until no more will pass. Place the 'on 76 mm' coke in the first large container and weigh. Repeat for sieves of 64, 51 and 38 mm.

4.6.4 Hand shake the residue on the 25 mm sieve plate for 100 movements. If the sieve is more than 75 percent covered at the end of the operation, make two complete operations. Add the 'on 25 mm' to the 'on 38 mm' coke and weigh. Hand shake the 13 mm sieve plate for 100 movements. If the sieve plate is not more than 75 percent covered at the end of the operation, add the 'on 13 mm' coke to the 'on 25 mm' coke. Sweep the 'through 13 mm' fraction on to a shovel and add to the 'on 13 mm' fraction.

4.6.5 Check that the total mass accounted for approximates closely to the 25 kg taken for the test. If the total is 24.9 kg or less, repeat the test.

4.7 Recording of Results

For the standard shatter test, it is usually satisfactory to record only the 51, 38 and 13 mm shatter indices. For the standard shatter test, the records noted are cumulative percentages on sieves of 102, 76, 64, 51, 38, 25 and 13 mm in kg. The loss during a test, which should not amount to more than 50 g, should be distributed more or less uniformly on the different fractions, weightage in this process of distribution being given to the larger sizes. An example is given in Table 2.

Table 2 Calculation of the Results of a Shatter Test
(Clause 4.7)

Fraction	Mass	Percentage Calculated	Percentage Adjusted
(1)	(2) kg	(3)	(4)
Over 51 mm	16.844	67.375	67.5
Over 38 mm up to 51 mm	3.094	12.375	12.4
Over 25 mm up to 38 mm	2.906	11.625	11.7
Over 13 mm up to 25 mm	1.531	6.125	6.2
Through 13 mm	0.531	2.125	2.2
	24.906	99.625	100.0

4.8 Reporting of Test Results

The average of three results obtained shall be reported for each shatter index.

4.9 Tolerance

The range of the results of the three tests carried out at different times in the same laboratory by the same operator with the same apparatus on three representative portions taken from the same sample after the last stage of the reduction process shall not differ by the following:

<i>Shatter Index</i>	<i>Maximum Acceptable Difference Between Results Obtained in the Same Laboratory</i>
38 mm	± 1.0 unit
13 mm	± 0.5 unit

5 MICUM TEST

5.1 Principle

The micum test is a relative measure of the resistance of coke to degradation mostly by abrasion. Coke, sieved to retain pieces over a specified size, is subjected to treatment under standardized conditions in a rotating drum. The results of size analysis of the treated coke are used as indices of the resistance to breakage by abrasion.

5.2 Number of Tests

Three tests shall be conducted.

5.3 Apparatus

The assembly of the apparatus is shown in Fig. 3.

5.3.1 Micum Drum

A welded mild steel drum of 100 ± 0.5 cm internal diameter and 100.0 ± 0.5 cm internal length, and made of plate of 6 mm thickness and the plate shall not wear to less than 5 mm with a horizontal shaft of about 6.5 cm diameter not passing through the drum, and mounted on suitable bearings. Four angle-irons with legs of $100 \times 50 \times 10$ mm are fitted longitudinally 90° apart at the periphery of the drum so that the legs point away from the direction of rotation of the drum. The drum is provided on the side with a door, 60×50 cm for introducing and removing the sample, the door being made dust-tight with a rubber washer and so fastened as to give a smooth inner surface. The bearings

are mounted on suitable side supports to allow a clearance of not less than 60 cm below the drum for convenient emptying after a test.

5.3.2 Sieve Plates

For sizing the samples for test, square mesh IS Sieves made of perforated plates having 50 mm as side of the squares are used. For sieving the coke after the Micum test, round hole punched plate screens, having 60 mm, 20 mm, 40 mm, and 10 mm as diameter of the apertures are used.

5.3.3 Balance

With an accuracy of ± 0.02 kg.

5.3.4 Containers

Of suitable size (see also 4.3.7).

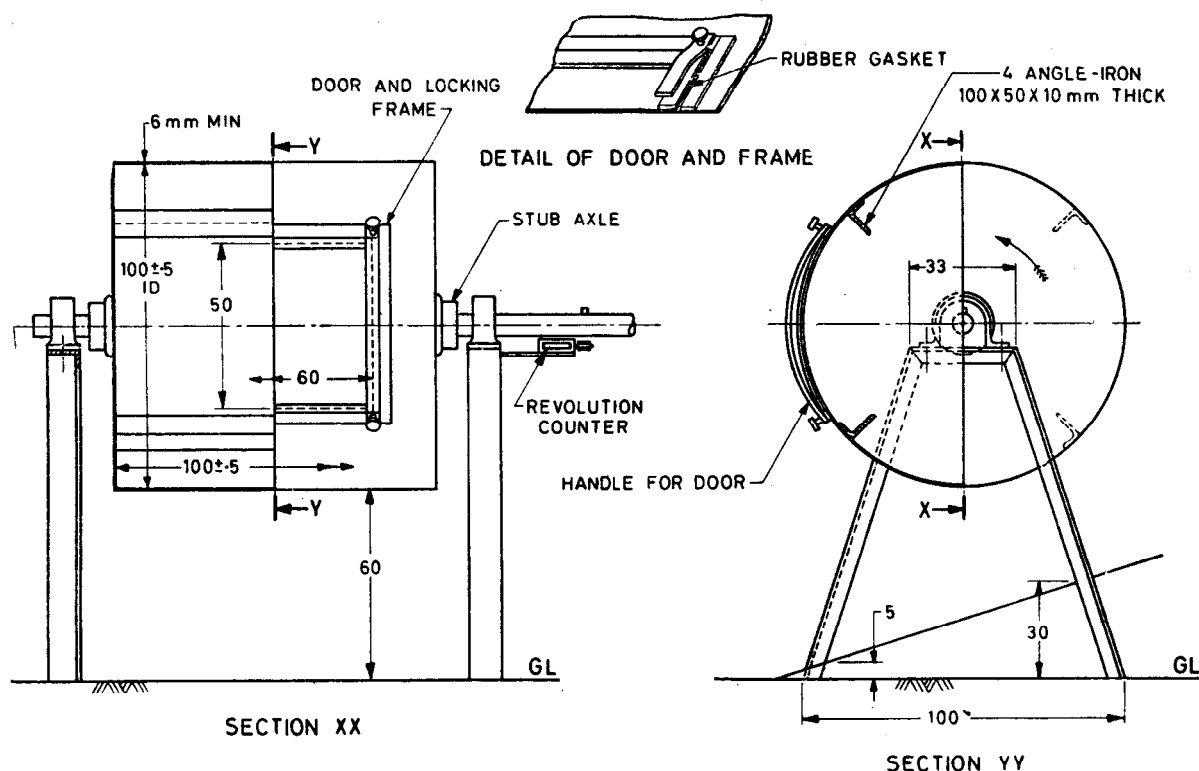
5.4 Preparation of Samples for Testing

Collect a gross sample, sufficient to provide about 50 ± 0.5 kg of coke for each of the three tests, so that, it may be representative of the sizes of the lumps over 50 mm size in the entire quantity of the coke under test. The sample shall consist of pieces none of which shall in any position pass through a 50 mm square mesh IS Sieve.

5.5 Procedure

5.5.1 Carefully place 50 ± 0.5 kg of the air-dried coke in the drum, avoiding any breakage of the coke. Moisture in the sample shall not exceed 3 percent. Fasten the cover rigidly and rotate the drum for 4 minutes at 25 rpm or a total of 100 revolutions, a margin of 10 seconds above or below 4 minutes being allowed to complete 100 revolutions.

5.5.2 Arrange a nest of perforated round-hole plates of 60 mm, 40 mm, 20 mm, and 10 mm apertures with the sieve of the largest aperture on the top. Shovel the coke from the base of the apparatus on to the top perforated plate, sweeping up the dust also into the plate. Shake vertically the top sieve plate to allow most of the under-size coke to pass through and hand place the residue on the sieve until no more will pass. Transfer the 'over 60 mm' coke into a container and record its mass to the nearest 20 g. Similarly, shake the 40-mm plate and hand place the residue on the sieve plate to determine whether in any position, it passes the sieve and then weigh to the nearest 20 g the coke retained on the plate. Vigorously shake the coke passing the 40 mm sieve on each succeeding sieve until no more coke passes



All dimensions in centimetres.

FIG. 3 MICUM TEST APPARATUS

through the opening. Separately weigh, to the nearest 20 g, the coke retained on the 20-mm and 10-mm sieve plates as also the coke passing through the 10-mm plate.

5.6 Report

Report the mean of the three Micum tests in cumulative percentages to the nearest 0.1 percent as follows:

Total Retained on	Percent Cumulative
M_{40} 40-mm screen	—
10-mm screen	—
Total passing through	
M_{10} 10-mm screen	—

5.7 Tolerance

5.7.1 In the Same Laboratory

The results of duplicate tests carried out at different times in the same laboratory by the same operator with the same apparatus on two

representative portions taken from the same sample shall not differ by more than the tolerances indicated below:

Micum Index	Maximum Acceptable Differences Between Results Obtained in the Same Laboratory
M 40	3.0 percent absolute
M 10	1.0 percent absolute

5.7.2 In Different Laboratories

No tolerance is possible for determination carried out in different laboratories because the transport of a coke sample involves the risk of breakage and thus alteration of the size distribution and the Micum indices.

6 HALF-MICUM TEST

6.1 General

There is considerable experimental evidence available to show that the mechanical strength of coke can be determined with a precision equal to that obtained in the Micum test (using 50 kg of coke as described in 5.2 to 5.6)

by using a drum 500 mm in length instead of 1 000 mm which is used in the Micum test while keeping the diameter of the drum unchanged and using a test coke portion of 25 kg.

There is no bias between the results obtained under the two different test conditions. Half-Micum test can be adopted as an alternate to Micum test when the availability of test coke sample is less. Preferably three tests shall be conducted as in the case of Micum test.

6.2 Apparatus

The apparatus shall be same as for the Micum test except that the length of the drum shall be 500 ± 5 mm.

6.3 Preparation of Samples for Testing

Proceed as described in 5.4 but prepare test portions of 25 ± 0.25 kg.

6.4 Procedure

Proceed as described in 4.4.1 and 4.4.2 except that use test coke portion of 25 ± 0.25 kg instead of 50 ± 0.5 kg.

6.5 Report

Report the mean of three Half-Micum tests in cumulative percentages to the nearest 0.1 percent as follows:

<i>Total Retained on</i>	<i>Percent Cumulative</i>
40-mm screen	
10-mm screen	
<i>Total Passing through</i>	
10-mm screen	

6.6 Tolerance

6.6.1 In the Same Laboratory

The results of duplicate tests carried out at different time in the same laboratory by the same operator with the same apparatus on two representative portions taken from the same sample shall not differ by more than the tolerances indicated below:

<i>Micum Index</i>	<i>Maximum Acceptable Differences Between Results Obtained in the Same Laboratory</i>
M 40	3.0 percent absolute
M 10	1.0 percent absolute

6.6.2 In Different Laboratories

No tolerance is possible for determination carried out in different laboratories because the transport of a coke sample involves the risk of breakage and thus alteration of the size distribution and the Micum indices.

7 TRUE SPECIFIC GRAVITY

7.1 Principle

For the purpose of this standard, specific gravity is equal to density (mass/volume) when the latter is in metric units. Weight in air is usually employed for calculation in place of mass and is readily determined for any material. For non-porous materials, such as metals, no difficulty arises in determining the volume; if the body is of regular shape the volume can be assessed from the dimensions; if of irregular shape, the volume can be assessed as the displaced volume, numerically equal to the difference between the weight in air and the weight when suspended in water.

For a porous material, it is necessary to distinguish between the apparent and true specific gravity, the latter referring to the intrinsic property of the substance which the porous material is made of and the former to the property of lumps of the porous material.

7.2 Number of Tests

Carry out the determination in duplicate.

7.3 Apparatus

7.3.1 Specific Gravity Bottle. — 50-ml.

7.3.2 Water-Bath — to hold the temperature at $40.0 \pm 0.5^\circ\text{C}$, preferably fitted with stirrer and a thermostat.

7.3.3 Reflux Air Condenser

7.3.4 Glycerine Bath

7.3.5 Wash Bottles — Containing air-free, recently boiled, distilled water.

7.4 Preparation of the Sample for Testing

Heat the coke at 105°C , grind to pass 212-micron IS Sieve, and keep in a vacuum desiccator.

7.5 Procedure

7.5.1 Clean the specific gravity bottle with potassium dichromate sulphuric acid mixture, rinse and fill with air-free (recently boiled) distilled water and allow the bottle with the

stopper fitted on it to stand in the water-bath for one hour at 40°C. Remove the water that collects at the top of the capillary with a piece of filter paper, cool rapidly under the tap for a few seconds, dry, allow to cool to room temperature by keeping near the balance case for at least half an hour and weigh.

7.5.2 Empty the bottle, dry the neck and add about 2 g of the prepared sample, accurately weighed, and 25 ml of air-free, recently boiled, distilled water. Fit the stopper and boil under partial vacuum in the glycerine bath for half an hour and wash down any scum with a small quantity of hot, air-free distilled water. Remove the stopper, fill with air-free distilled water (recently boiled) at about 40°C, put back the stopper and allow the bottle to stand for one hour in the water-bath. During this time, compensate for any contraction of the liquid by the addition of air-free distilled water at 40°C and displace any bubble of air below the stopper. Remove the blob of water from the top of the capillary with a piece of filter paper, cool rapidly under the tap for a few seconds, dry and allow to cool to room temperature leaving near the balance case for at least half an hour and weigh.

7.5.3 Repeat the determinations if the differences in duplicate results exceeds 0.01 g.

7.6 Calculation

$$\text{True specific gravity} = \frac{M}{M + M_1 - M_2} \times 0.99224$$

where

M = mass in g of dry coke,

M_1 = mass in g of the specific gravity bottle filled with water, and

M_2 = mass in g of specific gravity bottle with water and coke.

7.7 Report

Report the mean of the two determinations.

8 APPARENT SPECIFIC GRAVITY AND POROSITY

8.1 Principle

The apparent specific gravity of coke is of use in determining its porosity. The method described has been developed by the Coal Blending and Coking Research Laboratory (CBCR), Jamshedpur.

8.2 Number of Tests

Carry out three determinations on the sample.

8.3 Apparatus

8.3.1 Metallic Containers

Two, 33 cm in height, 56 cm in length, and 28 cm in width, one of them being provided with a spout, made of a nipple 7.5 cm in length and 1.25 cm in diameter, extending horizontally from the container 1.25 cm below the top.

8.3.2 Wire Cage

A basket 25 × 25 × 25 cm made of 1.25 cm square mesh screen wire cloth provided with a hinged cover and two handles at the sides, suitable for holding the entire sample of coke and so made as to fit inside the container below the spout.

8.3.3 Buckets

Two, each of 5-litre capacity, made of aluminium for receiving the displaced water.

8.3.4 Metallic Tank

For boiling water, 40 cm in height, 33 cm in length and 33 cm in width.

8.3.5 Balance

Of 10 kg capacity, sensitive to 1 g.

8.4 Procedure

8.4.1 Dry about 7 to 10 kg of a sample of coke, representative of the material with regard to size, shape and general appearance, to constant mass at 105 to 200°C. Place the container with spout on a level and rigid base and put a cork in the spout. Place the empty cage in the container, and apply a little vaseline to the free end of the spout to check the continued dripping of water at a later stage. Pour water at room temperature into the container until the water level is above the spout. After the water comes to rest, remove the cork from the spout and allow the excess water to drain out. Replace the cork and remove the cage from the water care being taken to shake all adhering water back into the container.

8.4.2 In the meantime fill the metal tank to about half with water and bring the water to boiling in advance.

8.4.3 Fill the cage with the dried and weighed sample, dip it in the boiling water and keep it dipped for half an hour. Remove the cage

from the metal tank, cool in cold water contained in the second container (without the spout). Then take out the cage with its content, allow to drip for one minute and then slowly immerse in the first container (with the spout). Allow the water to come to rest, and remove the cork and permit the displaced water to drain into the weighed aluminium bucket, the cork being replaced when the dripping of the overflow stream has stopped. Determine the mass of the displaced water.

8.5 Calculation

8.5.1 Apparent specific gravity = $\frac{M_1}{M_2}$

where

M_1 = mass of dry coke, and

M_2 = mass of water displaced by the wet coke.

8.5.2 Porosity, percent = $\frac{100 (X - Y)}{X}$

where

X = real specific gravity, and

Y = apparent specific gravity.

8.6 Report

Report the mean of the three results.

(Continued from second cover)

The special tests and the purposes for which they are significant are given below:

- a) *Shatter Test* — for metallurgical coke;
- b) *Abrasion Index (Micum indices, half-Micum indices)* — for metallurgical coke;
- c) *True Specific Gravity* — for general application;
- d) *Apparent Specific Gravity* — for general application; and
- e) *Porosity* — for metallurgical application.

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